PCT/AU2004/000998

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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003903831 for a patent by SPARR DRILLING EQUIPMENT PTY LTD as filed on 24 July 2003.

WITNESS my hand this
Ninth day of August 2004

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DOWNHOLE REVERSE CIRCULATION DRILL

FIELD OF THE INVENTION

This invention relates to a down hole reverse circulation drill.

This invention has particular application to a reverse circulation down hole face sampling hammer drill, and for illustrative purposes reference will be made to this application. However, it is envisaged that this invention may find application in other forms of drilling apparatus such reverse circulation tricone drills.

PRIOR ART

In the operation of sampling hammers it is understood that sampling integrity is improved if the hammer exhaust air used to flush cuttings is directed towards the cutting face of the bit. By this means chips are entrained at the point of their production. In Australian Patent Numbers 638571 and 656724, there are disclosed face sampling reverse circulation downhole hammers including a shroud or sleeve that extends beyond the lower end of the chuck or drive sub to surround the head of the bit, which is relieved to accommodate the sleeve or shroud.

The shroud or sleeve cooperates with air passages down the side of the bit head to direct air toward the cutting face of the bit. Air exhausted from the hammer free-piston motor passes down the splines that engage the bit for rotation and reciprocation in the chuck or drive sub. Air exits the lower end of the shroud or sleeve throught the air passaging grooves in the side of the bit head, to pass substantially to and across the cutting face of the bit.

Chippings are entrained in the air stream and conducted to the surface through sample apertures in the bit cutting face communicating with a sample

recovery conduit comprising an axial passage defined through the hammer to the inner tube of a dual wall drill string.

The shroud or sleeve is selected to be of substantially the same diameter as the gauge row of carbides of the bit head, and of greater diameter than the hammer casing, in order to provide a partial seal between the borehole and the hammer to constrain air to the cutting face of the bit and to thus substantially reduce both blowby of exhaust air and contamination of the sample from above.

The prior art hammers described above rely on the bit head itself to provide one wall of the conduits or passages conveying air towards the cutting face of the bit. The bit must necessarily run at a clearance from the sleeve, and the bit head necessarily oscillates relative to the sleeve. As a result of this, combined with the fact that the shroud or sleeve must stop well short of the cutting face to allow sufficient bit head metal to remain to support the gauge row, the air exiting the passages is not fully directed downward towards the cutting face through the grooves in the bit head exclusively. The exiting air also describes an outwardly expanding path from the passages, to be constrained by the borehole and turned across the cutting face of the bit. In tests it has been determined that the divergence from the vertical direction of the air flow is between 30 to 40° included angle.

In a further prior art hammer, an extended lower bearing surface on the bit shank cooperates with a bore in the lower end of the drive sub. The bore is relieved with four lenticular section cut-outs to provide for egress of exhaust air, the cut-outs being indexed to respective grooves down the side of the bit head. The bit head is shortened to bring the egress point closer to the face of the bit. This embodiment may be termed a sleeved sub/short bit head type. Again, the

bearing surface oscillates relative to the bore and the cut-outs well short of the cutting face to allow sufficient bit head metal to remain to support the gauge row. Accordingly, the air exiting the passages is not fully directed downward towards the cutting face through the grooves in the bit head exclusively. The exiting air also describes an outwardly expanding path from the passages, to be constrained by the borehole and turned across the cutting face of the bit.

In soft ground, the turbulence and expansion of air exhausted from prior art hammers tends to scour the borehole such that the hole is significantly larger than the gauge sleeve. This in turn causes loss of seal resulting in loss of sample up the borehole. As air velocity up the sample recovery conduit is lost through blowing by the seal, there is an increased tendency of the conduit to block, particularly at the sample return holes in the drill bit.

In WO01/21930 there is provided drilling apparatus including a chuck, a drill bit supported in the chuck and having a bit head extending below the chuck, the bit head having longitudinal air channels defined down the outside of the bit and extending through the cutting face, a gauge sleeve secured in relation to said chuck, and air passages defined between the gauge sleeve and the chuck having a terminal portion extending substantially parallel to the axis of the drill bit and substantially in register with the air channels. This construction again has the disadvantage of the air diverging from the lower end of the channels over the length of the bit head, tending to scour the bore hole at the cutting face level.

DESCRIPTION OF THE INVENTION

In one aspect the present invention relates to a reverse circulation downhole hammer including:

a drive sub or chuck mounted on a reverse circulation air hammer casing; and

a reverse circulation drill bit having a bit shank mounted in splined relation to said drive sub or chuck and a bit head adapted to extend below said chuck, the air hammer motor exhausting down the splines, an annular groove in said bit shank adjacent said bit head and extending to intersect the lower end of the bit shank splines, a sleeve secured to said bit shank over the lower end of said bit shank splines and substantially closing over said groove to form a manifold for exhaust air exiting said splines, said bit head having at least one air passage therethrough and intersecting said manifold, said air passage having a lower end directing air to the cutting face of the bit through an outlet through the side of the bit head adjacent the gauge row thereof communicating with a channel passing from said outlet to said cutting face, and an upper end directing sample accelerating air up the sample recovery bore of said bit.

The chuck may be of any suitable form. For example, the chuck may comprise the type associated in the DTH hammer art as a drive sub, or alternatively may comprise the variant known as a SAMPLEX chuck. The chuck may be secured to the hammer casing by any suitable means.

The splines may be of a typical form, where the splines are milled, the milling tool advancing the spline toward the bit head and stopping short of the bit head to avoid the milling tool from removing bit head material. The groove may be formed by milling or turning. Typically there will be a progressive change of section between the splined portion of the bit shank and the bit head to avoid stress concentration. For example the bit may be formed with two changes of section between the shank proper and the bit head. The grrove may

advantageously follow the profile of the change in section to retain the resistance to stress concentration.

The sleeve may in turn have an inner bore that is sustantially cylindrical to engage the shank over the lower end portion of the splines, and may have a section that parallels the bottom surface of the groove to provide a manifold of substantially rectangular and thus maximized section. The sleeve may be an interference fit on the splines. The sleeve may be shrunk onto the splines. The sleeve may be retained by mechanical means such as threading, the threads on the bit shank being advantageously formed before milling of the splies. The sleeve may be secured by a roll pin or the like, or grub screw. The sleeve may be adapted to slide in tolerance with a counterbored portion of the drive sub or chuck. In this case the roll pin or the like may be retained by the drive sub.

The sleeve may be adapted to cyclically open a port in the chuck side wall to allow exhaust air to escape up the outside of the drill string to clear fines from the borehole.

The at least one air passage defined between the sample recovery bore and the side of the bit head adjacent the gauge row is preferably one air passage for each carbide in the gauge row, the material of the bit head being relieved between the portions supporting the gauge row buttons to form the grooves, allowing the flushing air to pass to the face of the bit, entraining sample for recovery. The air passage is preferably formed by straight drilling at an angle to the drill bit axis from the side of the bit head adgacent the gauge row to the sample recovery bore above the bit head, the straight drilling preferably intersecting the groove over the maximum section of the groove.

The bit head may be provided with other ports into the air passage for specific purposes. For example there may be provided a passage from the air passage to the side of the bit head at its mavimum diameter to provide an air seal against the bore hole.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention and wherein:

FIG. 1 is a section through a chuck and bit assembly in its bit-closed-up position;

FIG 2 is a section through the chuck and bit assembly of FIG. 1 in a bit-extended position;

FIG 3 is an alternate section through the chuck and bit assembly of FIG. 1;

FIG 4 is section through the bit of chuck and bit assembly of FIG. 1, showing the groove formed thereon; and

FIG 5 is the bit of FIG. 4 with the sleeve installed.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the Figures there is provided a drive sub of chuck 10 having splines 11 and a counter bored portion 12. Mounted for reciprocation in the chuck 10 is a drill bit 13 having a bit shank 14 and a bit head 15. The bit head 15 has a bit face 16 bounded by a series of gauge row mounting portions 17, each of which has a carbide button insert 20, the carbide button inserts 20 forming the gauge row. A pair of sample recovery passages 21 open into the face 16 and are siamesed into an axial sample recovery conduit 22 through the drill bit and allowing recovered

sample to pass ultimately into the inner bore of a dual-wall drill string mounting the hammer (not shown).

The bit shank 14 has longitudinal splines 23 milled in its surface and extending toward a change of section 24 turning into the bit head 15. The bit shank splines 23 cooperate with chuck splines 11 to rotate the bit 13 while enabling the hammer to reciprocate the bit in the chuck 10. The respective splines 23, 11 are proportioned to allow hammer motor exhaust air to pass down the splines.

The bit shank splines 23 have their ends turned off by turning or milling of a groove 25 at the change of section 24. A sleeve 26 is fitted over the bit shank splines 23 and extends to the bit head 15. The sleeve 26 has a tapered bore 27 at the portion overlaying the groove 25, whereby a substantially rectangular-sectioned, annular air manifold 30 is formed by the groove 25, tapered bore 27 and shoulder of the bit head 15.

A channel 31 is formed between each button 20 in the gauge row and extending from the face of the bit 16 to a portion 32 of the bit head of maximum diameter. An air passage 33 is drilled from the inner end of each channel 31 at an angle to the bit axis to intersect the air manifold 30 and continue on to intersect the sample recovery bore 22.

The outer surface of the sleeve 26 is a close sliding fit in the counter bored portion 12 of the chuck 10 and forms therewith a slide valve for a port 34 through the chuck wall and angled toward the drill string. The port 34 is opened to exhaust air at maximum extension of the bit to allow exhaust air to flush the borehole around the drill string.

The portion 32 of the bit head of maximum diameter is provided with transverse drillings 35 intersecting the air passages 33 and exiting the bit head at chambers 36. Air passing from the air passage 33 to the chambers 36 forms an air seal with the borehole preventing material from passing from the borehole above the bit to the cutting face 16, reducing sample contamination from the strata above the cutting face.

It will of course be realized that while the above has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as described herein.

CLAIM

1. A reverse circulation downhole hammer including:

a drive sub or chuck mounted on a reverse circulation air hammer casing; and

a reverse circulation drill bit having a bit shank mounted in splined relation to said drive sub or chuck and a bit head adapted to extend below said chuck, the air hammer motor exhausting down the splines, an annular groove in said bit shank adjacent said bit head and extending to intersect the lower end of the bit shank splines, a sleeve secured to said bit shank over the lower end of said bit shank splines and substantially closing over said groove to form a manifold for exhaust air exiting said splines, said bit head having at least one air passage therethrough and intersecting said manifold, said air passage having a lower end directing air to the cutting face of the bit through an outlet through the side of the bit head adjacent the gauge row thereof communicating with a channel passing from said outlet to said cutting face, and an upper end directing sample accelerating air up the sample recovery bore of said bit.

DATED THIS TWENTY-FOURTH DAY OF JULY, 2003

BY

SPARR DRILLING EQUIPMENT PTY LTD

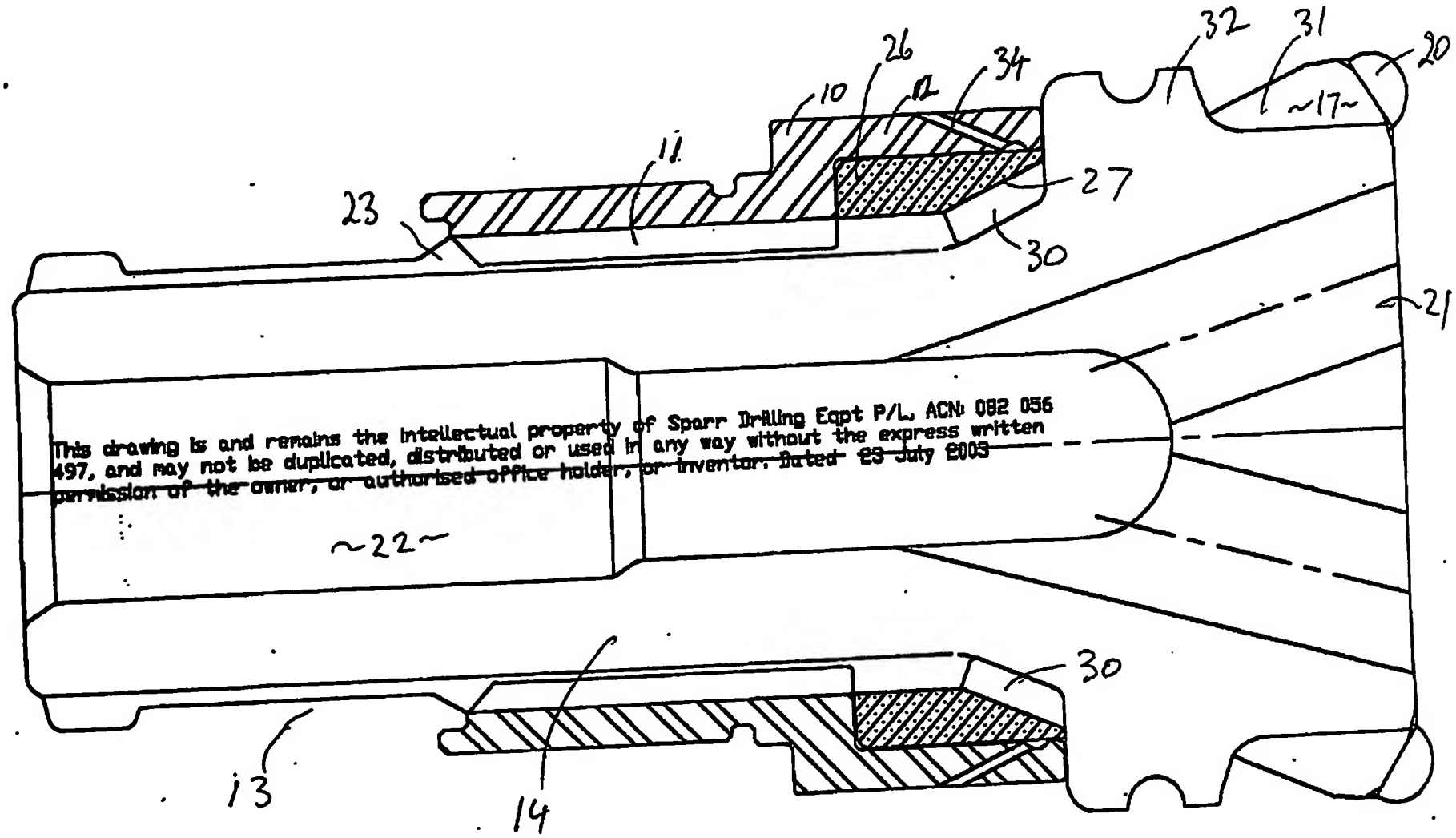
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Fig 1

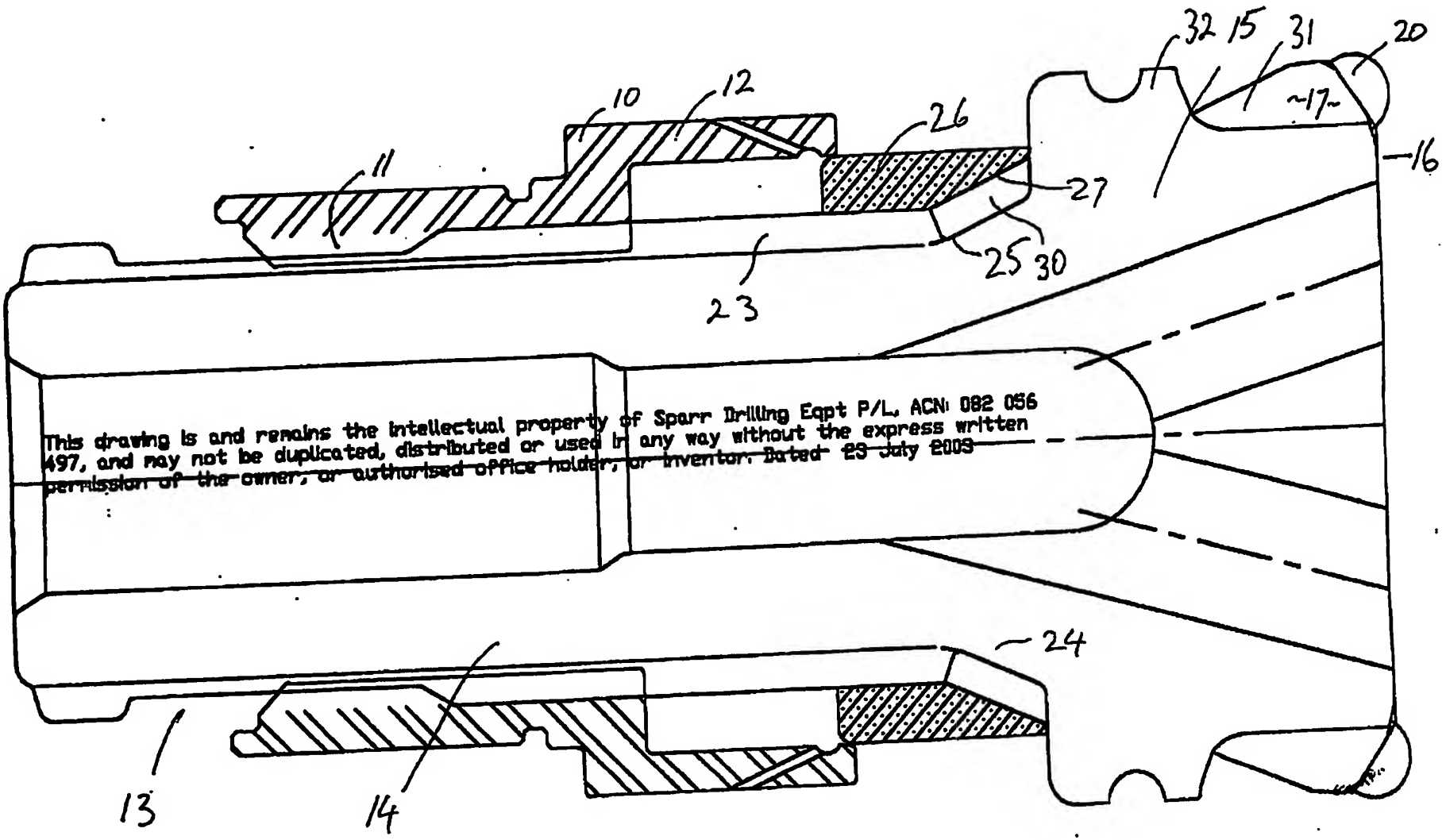

Fig 2

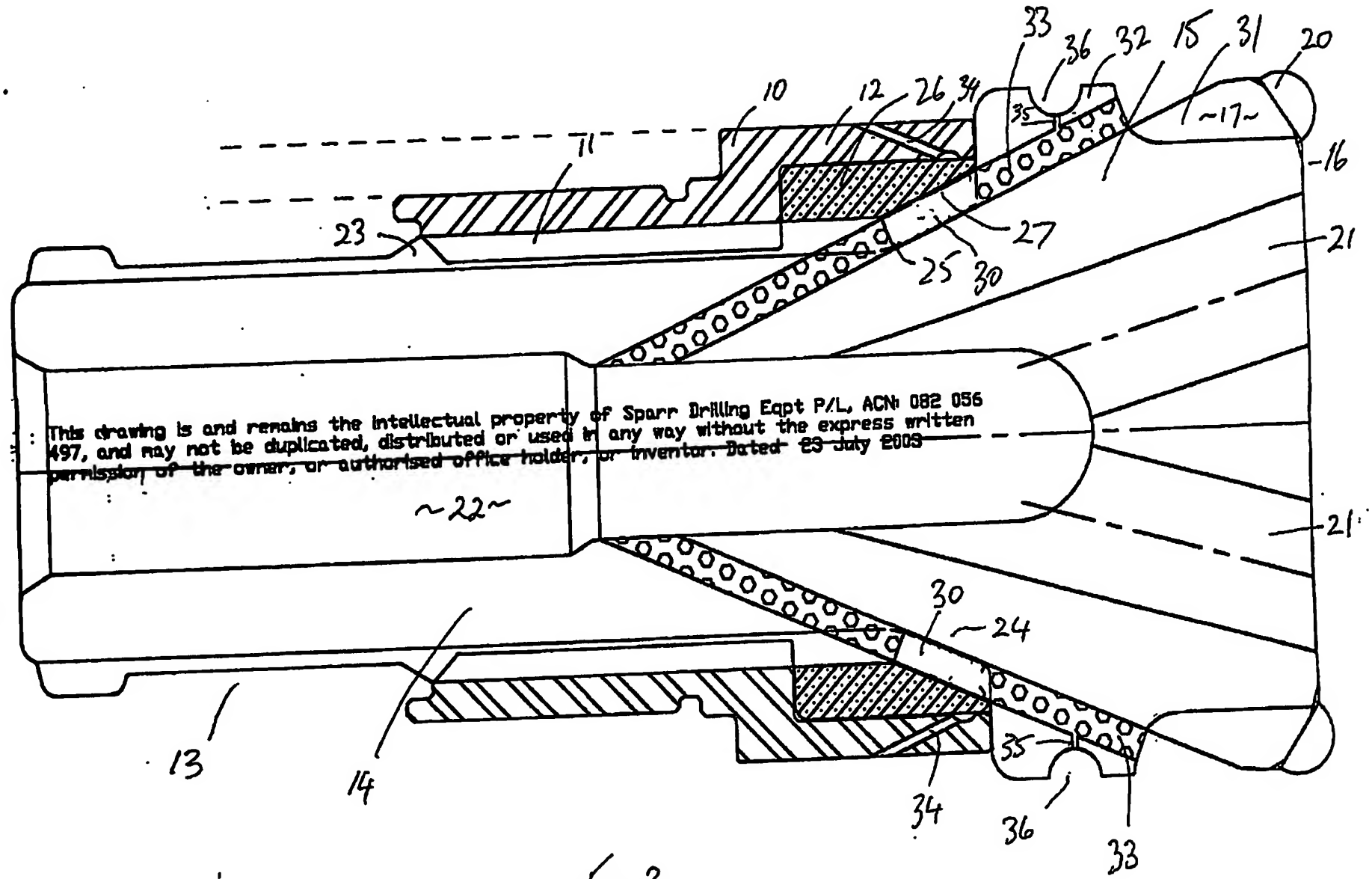
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Fig 3

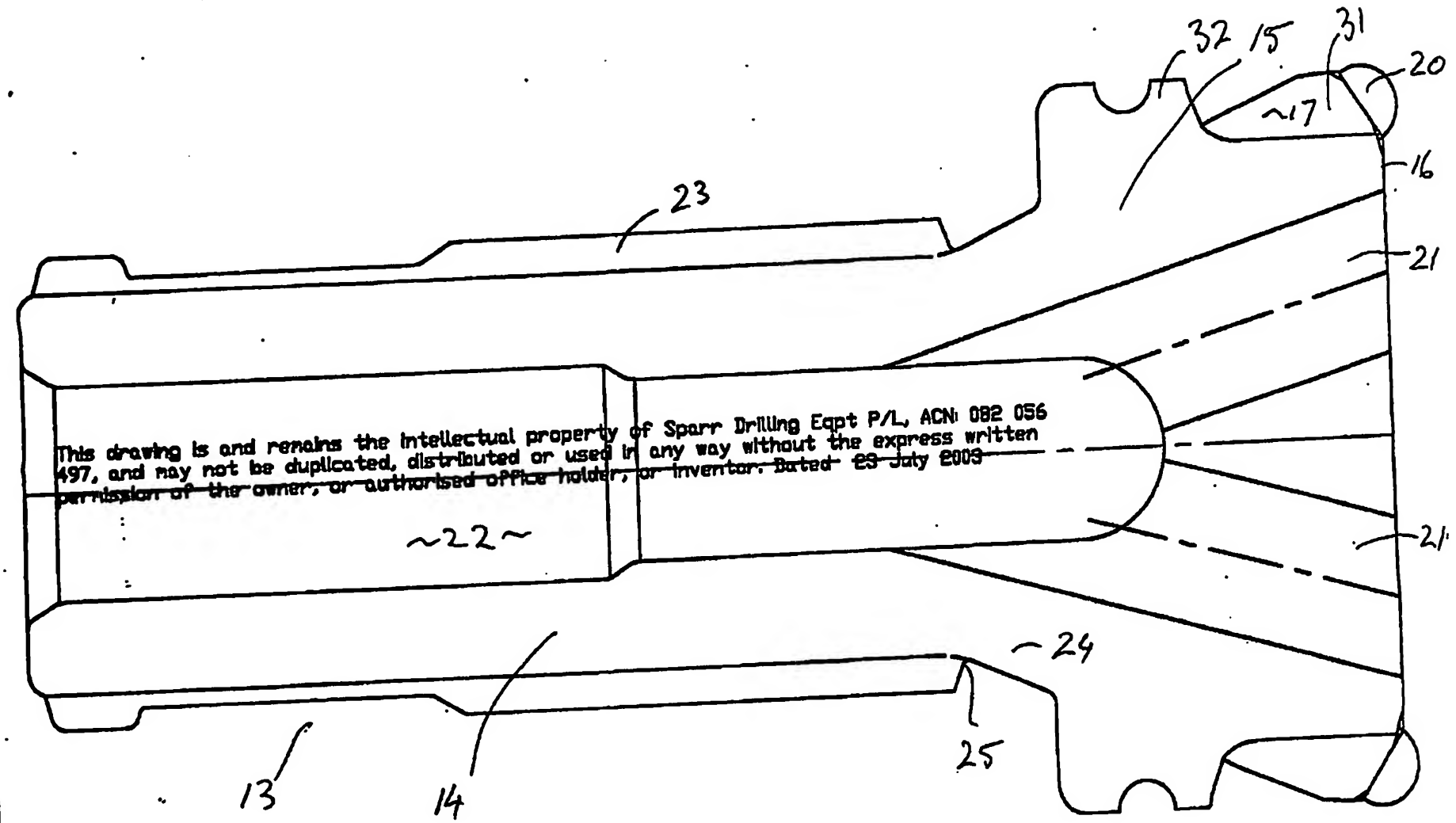
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Fig 4

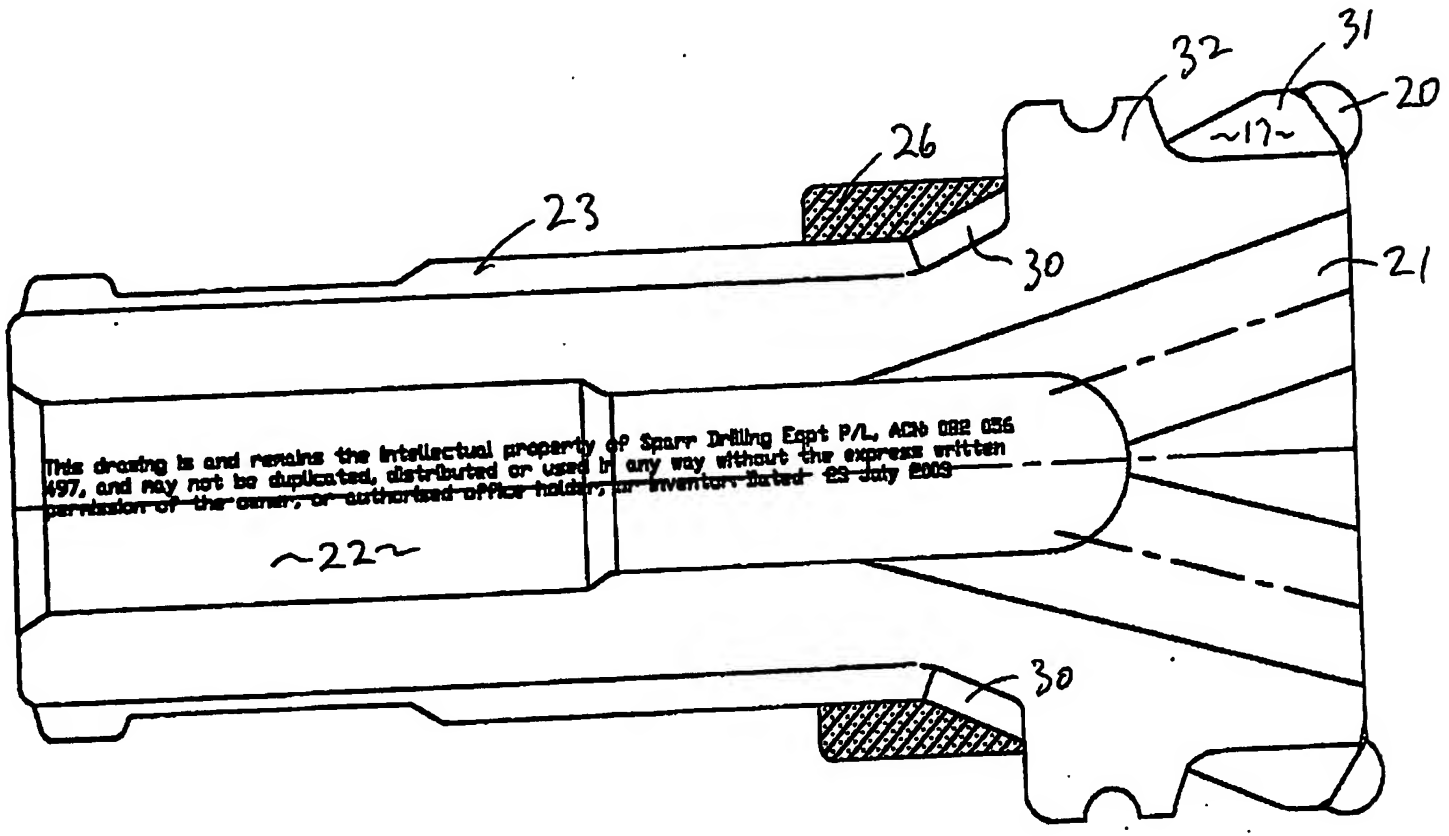
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Fig. 5